**A.C.-03.08.2022**
**Appendix-64**

**UNIVERSITY OF DELHI**

**DEPARTMENT: CHEMISTRY**

**COURSE NAME: B.Sc. in Analytical Chemistry**

**(Semester-I)**

Based on

Undergraduate Curriculum Framework-2022 (UGCF)

(Effective from Academic Year 2022-23)

University of Delhi

Course Name: B.Sc. in Analytical Chemistry (Semester- I) List of DSC Papers

| Course Title | Nature of the Course | Total Credit | Components | | | Eligibility Criteria Prerequisite | Contents of the course and reference is in |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| Basic Principles and Laboratory Operations | DSC-1: Analytical Chemistry | 04 | 02 | 00 | 02 | Physics, Chemistry and Mathematics | **Annexure-I** |
| Fundamentals of Organic Chemistry, Stereochemistry and Hydrocarbons | DSC-2: Chemistry | 04 | 02 | 00 | 02 | Physics, Chemistry and Mathematics | **Annexure-II** |
| Mechanics | DSC-3: Physics | 04 | 02 | 00 | 02 | Physics, Chemistry and Mathematics | **Annexure-III** |

# Discipline Specific Courses (DSC)

## SEMESTER 1

**Course Code: ANALYTICAL CHEMISTRY-1 (DSC1-AC1)**
**Course Title: Basic Principles and Laboratory Operations**
**Total Credits: 04 (Credits: Theory-02, Practical-02)**
**(Total Lectures: Theory- 30, Practical- 15 Classes of 4 hours each)**

**Objectives:** The objective of this course is to make students aware about the SI Units, concentration terms, various analytical methods, and safe usage of chemicals and its waste.

**Learning Outcomes:**

By the end of the course, the students will be able to:

- Understand about SI units
- Learn use of analytical equipments
- Know types of errors in chemical analysis
- Handle statistical tests of data
- Know safety with chemicals and waste.

### Unit 1: Basic Concepts

A. SI Units
- · Definitions of the Seven Base Units
- · Derived units
- · Conversion between units
- · Significant figures

B. Chemical concentrations
- · Mole, molar mass (calculations in grams and moles)
- · Solutions and their concentrations
- · Molar concentration
- · Analytical molarity
- · Equilibrium molarity of a particular species
- · Percent concentration
- · Parts per million/billion (ppm, ppb)
- · Volume ratios for dilution procedures
- · p-functions.

(Lectures: 5)

### Unit 2: Introduction to Analytical Chemistry and Analytical Methods

General steps in chemical analysis

Introduction to methods of detecting analytes

a) Physical
b) Electromagnetic radiations
c) Electric charge.

(Lectures: 5)

## Unit 3: Errors in Chemical Analysis

- Types of errors
- Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty
- The Gaussian distribution
- Mean and standard deviation
- Confidence intervals
- Statistical tests of data (F test, t test, Q test for bad data)
- Method of least squares
- Calibration curve
- Safety with chemicals and waste

(Lectures: 20)

## PRACTICALS (Credits: 02; Laboratory Periods: 60; 15 Classes of 4 hours each)

1. Description, Use and Calibration of Common Laboratory Apparatus I: Glassware: Volumetric flasks, Burettes, Pipettes, Weighing bottles, Drying ovens.
2. Description, Use and Calibration of Common Laboratory Apparatus II: Different types of Funnels, Chromatographic columns, Chromatographic jars, Desiccators, Filter crucibles, Rubber policeman.
3. Preparing Solutions: Standard solutions (acids and bases), primary standards and secondary standards, and to find out their concentration by any suitable methods.
4. Determination of strength of given strong acid using strong base volumetrically
5. Estimation of sodium carbonate by titrating with hydrochloric acid.
6. Use and maintenance of pH meter. Determination of pH of given dilute solutions of shampoos, soaps, fruit juices and different soft drinks.
7. Determination of cell constant of a conductometric cell using standard KCl solutions.
8. To check the conductivity of various water samples (*Collect at least four samples*).

## REFERENCES:


- Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.
- Skoog, D.A.; West, D.M. (2003), Fundamentals of Analytical Chemistry, Brooks/Cole.
- Christian, G.D. (2004), Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
- Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.


## Additional References


- Day. R. A.; Underwood, A. L. (1991), Quantitative Analysis, Prentice Hall of India.

- Gordus, A. A. (1985), Schaum's Outline of Analytical Chemistry, Tala McGraw-Hill.
- Dean J. A. (1997), Analytical Chemistry Handbook, McGraw Hill.
- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.


## Teaching Learning Process:

- Conventional chalk and board teaching
- Visit chemical industries/ Drug industries to get information about the various instruments used in industries
- ICT enabled classes
- Power point presentations
- Interactive sessions
- To get recent information through the internet.

## Assessment Methods:

- Class Tests at Periodic Intervals.
- Written assignment (s) / Presentation by individual students
- End semester University Theory and Practical Examination

**Keywords:** SI Units, Concentrations terms, Analytical methods, Laboratory operations, Electromagnetic radiation, Statistical methods, Errors.

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## Course Code: CHEMISTRY-1 (DSC2-C1)

## Course Title: Fundamentals of Organic Chemistry, Stereochemistry and Hydrocarbons

**Total Credits: 04 (Credits: Theory-02, Practical-02)**

**(Total Lectures: Theory- 30, Practical- 15 Classes of 4 hours each)**

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**Objectives:** The course is infused with the recapitulation of fundamentals of organic chemistry and visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts deferent class of mechanism included. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

### Learning Outcomes:

By the end of the course, the students will be able to:

- Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
- Understand the stereochemistry of aliphatic and aromatic hydrocarbons
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.

- Learn and identify many organic reaction mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, and electrophilic substitution.
- Understand the mechanism of reactions of hydrocarbons

## Unit I: Fundamentals of Organic Chemistry

Introduction to carbon compounds, an overview of Fundamentals (Electronic displacement- Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect). Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbene.

Acidity and basicity in carbon compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivative.

(Lectures: 05)

## Unit II: Stereochemistry

Types of projection formulas of carbon compound - Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.

Stereoisomerism: the concept of chirality (upto two carbon atoms). Configurational Isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; cis-trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).

Conformational isomerism with respect to ethane, butane and cyclohexane.

(Lectures:07)

## Unit III: Aliphatic Hydrocarbons

Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with the mechanism in context to their structure.

**Alkanes**: Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation.

**Alkenes**: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), the addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration - demercuration, Hydroboration oxidation.

**Alkynes**: Preparation: Acetylene from $CaC_2$ and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides and acidity of alkynes, the addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds

**(**Lectures:12)

## Unit IV: Aromatic Hydrocarbons

Aromaticity: benzenoids and Hückel's rule. Structure and aromatic character of benzene.

Preparation: methods of preparation of benzene from phenol, benzoic acid, acetylene and benzene sulphonic acid. Reactions: electrophilic substitution reactions in benzene citing examples of nitration, halogenation, sulphonation and Friedel-Craft's alkylation and acylation with emphasis on carbocationic rearrangement, side-chain oxidation of alkylbenzenes.

**(**Lectures: 06)

## PRACTICALS (Credits: 02; Laboratory Periods: 60; 15 Classes of 4 hours each)

1. Purification of organic compounds by crystallization using the following solvents:

   a. Water
   b. Alcohol
   c. Water + Alcohol

2. Determination of the melting points of organic compounds using Kjeldahl method and electrically heated melting point apparatus.
3. To study the effect of impurities on the melting point.
4. To identify the organic compounds using mixed melting point experiment. (*Identify at least two organic compounds*).
5. Determination of boiling point of liquid organic compounds using both distillation and capillary method.
6. Detection of extra elements present in an organic compounds (*Up to two extra elements*).
7. Organic Preparations:
   a. Bromination of acetanilide, phenol and aniline
   b. Nitration of nitrobenzene and bromobenzene

## REFERENCES:


**Theory:**

- Sykes, P.(2005), A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- Morrison, R. N.; Boyd, R. N. (2010) Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Edition.
- Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.

**Practical:**

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
- Mann, F.G.; Saunders, B.C.(2009), Practical Organic Chemistry, Pearson Education.
- Dhingra, S; Ahluwalia V.K., (2017), Advanced Experimental Organic Chemistry, Manakin Press.

**Teaching Learning Process:**

- Conventional chalk and board teaching
- Class interactions and discussions
- Power point presentation on important topics.
- Teaching Learning process is largely student focused

**Assessment Methods:**

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory Examination Presentations by Individual Student/ Group of Students

**Keywords:** Chirality, Aromaticity, Alkanes, Alkenes, Alkynes.

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## Course Code: PHYSICS-I (DSC3)
## Course Title: MECHANICS
**Total Credits: 04 (Credits: Theory-02, Practical-02)**
**(Total Lectures: Theory- 30, Practical- 15 Classes of 4 hours each)**

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Vectors: Review of vector algebra. Scalar and vector product

**(2 Hours)**

Ordinary Differential Equations: First order homogeneous differential equations, second order homogeneous differential equation with constant coefficients

**(4 Hours)**

Brief review of Newton's laws of motion, dynamics of a system of particles, centre of mass, determination of centre of mass for continuous systems having spherical symmetry. Conservation of momentum and energy, work – energy theorem for conservative forces, force as a gradient of potential energy, angular momentum, torque, conservation of angular momentum

**(9 Hours)**

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, kinetic energy and potential energy, total energy and their time average for a body executing simple harmonic motion

**(4 Hours)**

Newton's law of gravitation, motion of a particle in a central force field, Kepler's laws, weightlessness, geosynchronous orbit, basic idea of global positioning system

**(4 Hours)**

Elasticity: Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on a wire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus

**(3 Hours)**

Postulates of special theory of relativity, Lorentz transformation relations, length contraction, time dilation, relativistic transformation of velocity

**(4 Hours)**

**References:**

**Essential Readings:**


**1)** Schaum's Outline of Vector Analysis, 2nd Edn., Murray Spiegel, Seymour Lipschutz, Tata McGraw-Hill, (2009)

**2)** An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.

**3)** Mechanics Berkeley Physics Course, Vol. 1, 2/e, Charles Kittel, et. al., 2017, McGraw Hill Education

**4)** Mechanics, D. S. Mathur and P. S. Hemne, 2012, S. Chand.


**Additional Readings:**


**1)** University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**2)** University Physics, H. D. Young and R. A. Freedman, 14/e, 2015, Pearson Education.

**3)** Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.

**4)** Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.


## PRACTICAL (Credit: 02; 60 Hours; 15 Practicals of 4 hours each)

Every student should perform at least 06 experiments from the following list.

**1)** Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope.

**2)** Determination of height of a building using a sextant.

**3)** Study of motion of the spring and calculate (a) spring constant and, (b) acceleration due to gravity (g)

**4)** Determination of moment of inertia of a flywheel.

**5)** Determination of Young's modulus of a wire by Optical Lever Method.

**6)** Determination of modulus of rigidity of a wire using Maxwell's needle.

**7)** Determination of elastic constants of a wire by Searle's method.

**8)** Determination of value of g using bar pendulum.

**9)** Determination of value of g using Kater's pendulum.

**References:**


**1)** Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.

**2)** Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India

**3)** Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.

**4)** A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.

**5)** B. Sc. practical physics, Geeta Sanon, R. Chand, 2016